

## CLAIMS

1. A method for removing or otherwise reducing the level of certain chemical species in a sample, said method comprising subjecting said sample to one or both of anaerobic treatment conditions and/or aerobic treatment conditions wherein the valency of one or more redox mediator species is manipulated by microorganisms resulting in adsorption, precipitation, aggregation, flotation, or flocculation of the chemical species.
2. The method of Claim 1 wherein under anaerobic conditions, redox mediator species are reduced to a lower order valency and under aerobic conditions, redox mediator species are oxidized to a higher order valency by microorganisms and this in turn facilitates the formation of insoluble particles comprising particular chemical species.
3. The method of Claim 2 wherein the chemical species comprise inorganic molecules.
4. The method of Claim 2 wherein the chemical species comprise organic molecules.
5. The method of Claim 3 or 4 wherein the chemical species comprise proteins, fatty acids, lipids, ammonium, organic acids, phenolic compounds, aromatic polycyclic oxygenated compounds, nucleic acids, sulfates, phosphates, radionuclides and/or cyanides.
6. The method of Claim 1 wherein the sample is a liquid, semi-liquid, solid, particulate or gaseous environment or a portion thereof.
7. The method of Claim 6 wherein the sample is an environmental, industrial or domestic sample.

8. The method of Claim 1 or 6 wherein the sample is wastewater, water, solid waste, or polluted soil.
9. The method of Claim 2 wherein the redox mediator species are selected from the group comprising zero valence metal pieces, metallic ions, metal-containing oxides, hydroxides, chelates, non-biodegradable and insoluble inorganic constituents with variable oxidation-reduction states and combinations thereof.
10. The method of Claim 9 wherein the metallic and metal-containing species include metals selected from the group comprising iron, nickel, cobalt, manganese, vanadium and combinations thereof.
11. The method of Claim 9 or 10 wherein the cationic metal is provided as metal salts or metal slurry.
12. The method of Claim 9 or 10 wherein the iron-reducing microorganisms are selected from the genera: *Acidobacterium*, *Aerobacter*, *Bacillus*, *Clostridium*, *Deferribacter*, *Desulfuromonas*, *Desulfuromusa*, *Escherichia*, *Ferribacterium*, *Ferrimonas*, *Geobacter*, *Geovibrio*, *Geothrix*, *Pantoea*, *Pseudomonas*, *Sulfurospirillum*, *Shewanella*, *Thermoterrabacterium*, *Thermotoga*, *Thermus* and/or mixed cultures of the aforementioned microorganisms, and/or enrichment cultures of the microorganisms capable to reduce iron (III).
13. The method of Claim 9 or 10 wherein the iron-oxidizing microorganisms are selected from genera *Acidianus*, *Acidithiobacillus*, *Ferroglobus*, *Ferromicrobium*, *Gallionella*, *Hyphomicrobium*, *Leptothrix*, *Naumanniella*, *Ochrobium*, *Leptospirillum*, *Pedomicrobium*, *Rhodovulum*, *Rhodocyclus*, *Siderococcus*, *Sphaerotilus*, *Siderocapsa*, *Sulfolobus*, *Stenotrophomonas*, *Thiobacillus* and/or mixed cultures of the aforementioned microorganisms, and/or enrichment cultures of the microorganisms capable to reduce iron (III).

14. A method for removing or otherwise reducing the level of inorganic and/or organic chemical species in wastewater, surface water, ground water, solid waste, and/or polluted soil, said method comprising subjecting said wastewater, surface water, ground water, solid waste, and/or polluted soil to one or both of anaerobic treatment conditions and/or aerobic treatment conditions wherein the valency of one or more cationic iron species is manipulated by microorganisms where under anaerobic conditions, cationic iron species are reduced to a lower order valency and under aerobic conditions, cationic iron species are oxidized to a higher order valency by microorganisms and this in turn facilitates the formation of insoluble particles comprising the chemical species.

15. The method of Claim 14 wherein the chemical species comprise inorganic molecules.

16. The method of Claim 14 wherein the chemical species comprise organic molecules.

17. The method of Claim 15 or 16 wherein the chemical species comprise proteins, fatty acids, lipids, ammonium, organic acids, nucleic acids, sulfates, phosphates radionuclides and/or cyanides.

18. The method of Claim 14 wherein the iron-reducing microorganisms are selected from the genera: *Acidobacterium*, *Aerobacter*, *Bacillus*, *Clostridium*, *Deferribacter*, *Desulfuromonas*, *Desulfuromusa*, *Escherichia*, *Ferribacterium*, *Ferrimonas*, *Geobacter*, *Geovibrio*, *Geothrix*, *Pantoea*, *Pseudomonas*, *Sulfurospirillum*, *Shewanella*, *Thermoterrabacterium*, *Thermotoga*, *Thermus* and/or mixed cultures of the aforementioned microorganisms, and/or enrichment cultures of the microorganisms capable to reduce iron (III).

19. The method of Claim 14 wherein the iron-oxidizing microorganisms are selected from the genera *Acidianus*, *Acidithiobacillus*, *Ferroglobus*, *Ferromicrobium*, *Gallionella*, *Hyphomicrobium*, *Leptothrix*, *Naumanniella*, *Ochrobium*, *Leptospirillum*,

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*Pedomicrobium*, *Rhodovulum*, *Rhodocyclus*, *Siderococcus*, *Sphaerotilus*, *Siderocapsa*, *Sulfolobus*, *Stenotrophomonas*, *Thiobacillus* and/or mixed cultures of the aforementioned microorganisms, and/or enrichment cultures of the microorganisms capable to reduce iron. (III).